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Hewett A Century of
Mining and Metallurgy
in the United States
1876

A CENTURY

OF

MINING AND METALLURGY

IN THE

UNITED STATES.

CENTENNIAL ADDRESS

OF

HON. ABRAM S. HEWITT,

PRESIDENT ELECT OF THE AMERICAN INSTITUTE OF MINING ENGINEERS.

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A CENTURY OF MINING AND METALLURGY IN THE UNITED STATES.

GENTLEMEN: If my first words were other than those of thanks for the high honor of being called to preside over the American Institute of Mining Engineers, I should do injustice alike to you and to my own sense of the obligation, under which I have been placed by your voluntary choice. When the position was first suggested to me, I resolutely declined to allow the use of my name, on the ground that, by training and occupation, I was not entitled to this honor, which, it then seemed to me, should be conferred only on a professional engineer. In fact, the history of the Institute, which had honored itself, as well as my distinguished predecessors, David Thomas, Rossiter W. Raymond, and Alexander L. Holley, by elevating them to its highest office, seemed to indicate the line and the limit of safe precedent, in which I did not then see how I could be included.

But my scruples were finally removed by the consideration that, as in the course of human industry, the pioneer, of whom Mr. Thomas was so marked a type, must precede the mining engineer, so fitly personified in Dr. Raymond, and be followed by the mechanical engineer, whose incarnation we behold in Mr. Holley; so all these must be supplemented by the man of affairs and finance, in order that "enterprises of great pith and moment" may be prosecuted to a successful issue. I felt, therefore, that I had no longer any right to resist your preference, or to deprive myself of what I must regard as the crowning honor of an active career.

On an occasion like the present it seems appropriate to review the history in this country, during the last hundred years, of those industries which the Institute of Mining Engineers specially represents. There is much in the story with which other members of this body are more familiarly acquainted than myself; yet I fancy that to all

of them, and not less to our distinguished and most heartily welcome guests from abroad, a comprehensive outline of the progress of mining and metallurgy in the United States will prove interesting. I ask your attention, therefore, to a condensed account of that subject, embracing a statement of the beginnings of the industry on our shores of the notable events attending its increase, and of its present condition after a hundred years of national life. The extent and rate of our progress will be shown more clearly by figures than by words, and I shall offer a series of tables, carefully compiled from the best available sources, and showing the production of each of the leading metals, year by year. This general survey would be incomplete without some account of the legislation of the Federal government with regard to mining, the principles upon which it has been based, the effects which it has produced; and, finally, I shall attempt to point out some causes and agencies which, under our institutions and habits, may be, in my opinion, relied upon to effect certain great ends of technical efficiency, political economy, and social equity, which our government has not attempted, and could not fairly be expected, to achieve.

Many of the topics I have named are more or less familiar to me in my experience as a man of business, a student of public affairs, and a zealous inquirer into the social and industrial problems of the present generation. But the collection and arrangement of facts in my possession, the search for other facts to complete the record, and the orderly expression of the whole in connected form, would have been a labor at this time utterly beyond my powers, already overtaxed by intense and continuous occupation in another sphere, had I not been able to avail myself of the assistance of Dr. Raymond, whose thorough acquaintance with a large portion of the field I was attempting to cover, and whose ready comprehension of the nature of my plan enabled him to render me a service so essential that I cannot consent to omit an explicit recognition of it.

Mining enterprises were among the motive powers to the exploration, conquest, and colonization of the New World. The desire to find a shorter route to the profitable trade of India, the desire to conquer new territory, wherever it might be found, in the name of some Catholic or Protestant sovereign of Europe, were accompanied, both in North and South America, by eager hopes of the discovery of gold and silver.

The history of the plunder of the metallic wealth and the development of the mineral resources of Mexico and South America, does

not lie within my present purpose. The early enterprises of this kind in the northern part of the continent were less successful, though the progress of two hundred years has made them more beneficial to national prosperity, for reasons which I shall, perhaps, be able to indicate.

Gold was found in moderate quantities in use among the Indian tribes of the present Southern States. The Spaniards under De Soto, following this clue, and led on by stories, exaggerated or misunderstood, of their Indian guides, made a wide superficial exploration in search of the origin of this treasure. They are supposed to have excavated many of the diggings in North and South Carolina and Georgia, which are now overgrown with forests. But no rich deposits appear to have been discovered, and no permanent operations undertaken.

In the great charter of King James, by which, in 1606, the right to explore and settle the North American continent from the thirty-fourth to the forty-fifth parallel, was granted to the London and Plymouth Companies, it was provided that one-fifth of the gold and silver, and one-fifteenth of the copper, which might be discovered, should belong to the crown. One of the earliest expeditions of Captain John Smith, in Virginia, was the exploration of the Chickahominy River, in the hope that it might constitute a water-way to the Pacific Ocean; and one of the next events in the history of the same colony was a mining excitement, such as would be called in our California tongue a "stampede," caused by the supposed discovery of gold; in which, fortunately, John Smith did not avail himself of his official position to take "stock." It is a curious circumstance that gold really occurs in that region, though the glittering dust, of which a ship-load was sent by the deluded colonists to the jewelers of London, proved to be but mica or iron-pyrites; and it seems probable (albeit this suggestion is not based upon any explicit record known to me) that the presence of gold among the Indians, and the discovery of specimens of the quartz or slates of Virginia, containing visible particles of it, gave rise to the general excitement, under the influence of which, without further tests of value, a large amount of worthless material was collected, to the neglect of necessary and profitable industry. From this point of view the Jamestown mining fever was the prototype of many that have since occurred—all of which may be summed up in the general expression, that the mine "did not pan out according to the samples."

A more promising industry was inaugurated at the same time by

the sending of a quantity of iron ore from Jamestown to England in 1608. This ore, smelted in England, yielded seventeen tons of metal, probably the first pig-iron ever made from North American ore. In 1620, a hundred and fifty skilled workmen were sent to the colony to erect iron-works; and it is said that a fund, subscribed for the education of the colonists and Indians, was invested in this enterprise, as a safe and sure means of increase. But, in 1622, an Indian massacre broke up the enterprise; and both the manufacture of iron and the education of citizens and Indians have been obliged, ever since, to rely upon other sources of support.

For an interesting collection of facts relative to the beginnings of the iron industry of the American colonies, I refer you to the forthcoming work on that subject, by our fellow-member, Mr. John B. Pearse, to whose courtesy I am indebted for the opportunity to consult the advance sheets of a portion of the book.

According to the statement of Colonel Spotswood, quoted by Mr. Pearse, it appears that, previous to 1724, neither New England, Pennsylvania, nor Virginia, possessed blast furnaces. Their product of iron was from bloomeries only. According to Prof. Hodge, quoted by Prof. Whitney, however, a furnace was built at Pembroke, Mass., in 1702; and another authority states that, in 1721, New England possessed six furnaces and nineteen forges. In 1719 was passed the famous resolution of the British House of Commons, "that the erection of manufactories in the colonies tended to lessen their dependency on Great Britain." Only the earnest protest of the colonial agents prevented the prohibition at that time of the American iron manufacture. The next thirty years witnessed two instructive contests. The first was that of the colonial with the domestic pig-iron manufacture—a competition in which America was favored by the abundance of her vegetable fuel (the employment of mineral coal in iron-making not having yet found introduction), in comparison with the rapidly waning forests of Great Britain. The British manufacture being protected by heavy duties on colonial pig-iron, the latter began to be more and more worked up into bar-iron, nails, steel, etc., at home; and this brought on a new competition with the British manufacturers of these articles. In 1750, a further legislative attempt to regulate this trade was made by Parliament, which decreed the admission of colonial pig-iron duty free, but prohibited the erection in America of slitting, rolling, or plating mills, or steel furnaces, ordering that all new ones thereafter built should be suppressed as "nuisances."

It will be recollected that arbitrary acts of this kind, for the destruction of our infant manufactures, were among the grievances cited in the Declaration of Independence. The extent of the American iron manufacture, during the ante-revolutionary period, can be inferred only from scanty records of exports. These, beginning in 1717 with three tons, had increased, in 1750, to about 3000 tons; in 1765, the total is reported at 4342 tons; and, in 1771, at 7525 tons, the maximum annual export. The outbreak of the war of course put an end to exportation and caused a great demand for war material, which occupied and rapidly extended the means of manufacture possessed by the country. The expanded iron industry suffered a severe collapse when, at the close of the war, not only this demand ceased, but the reopened ports admitted large quantities of foreign iron—the successful employment of mineral coal, the steam engine and puddling having by that time laid the foundation of English supremacy in the iron manufacture.

The earliest copper-mining company of which we find any record—according to Prof. Whitney, in his excellent work on the metallic wealth of the United States, the earliest incorporated mining company of any kind—was chartered in 1709, to work the Simsbury mines, at Granby, Conn. These mines were abandoned in the middle of the eighteenth century, afterwards bought by the State of Connecticut, and used as a prison for sixty years. Mining was resumed in them about 1830, and after a few years they were again abandoned. The ores were mostly shipped to England, and seem to have been lean. The deposit belongs to the class of irregular bunches, nodules, seams, or limited beds, in the New Red Sandstone, near its junction with trap. This formation was the scene in New Jersey, also, of early mining activity. The Schuyler mine, near Belleville, on the Passaic, was discovered about 1719, and proved more profitable to its owners before the Revolution than it ever has been since that time, to any of the series of individuals and companies that have expended large sums in its development. In fact, the chief blessing conferred upon mankind by the Schuyler mine arises from the circumstance that the first steam engine ever built wholly in America was constructed in 1793–4, at the small machine shop attached to the smelting works at Belleville, my father being the pattern-maker in the party of mechanics sent out by Boulton & Watt for the purpose of erecting an engine for the Philadelphia Water-works in Centre Square. In 1751 a copper mine was opened near New Brunswick; and the Bridgewater mine, near Somerville, was operated pre-

vious to the Revolution, though even then, it is said, with much loss of capital. New Jersey's record in copper-mining is not a cheerful one; but her unsurpassed ranges of iron ores may well console her. Betrayed by the treachery of Triassic and trap, she can flee to the shelter of the crystalline schists. Pennsylvania was not without her copper-mining in the colonial period, the Gap mine, in Lancaster County, having been opened in 1732.

Already during the colonial period the first red gleams of the future glory of the Lake Superior mines had appeared. The intrepid Jesuit fathers, Marquette and others, who penetrated the wilderness from Acadia to the Gulf, to carry both the Cross of their religion and the Lillies of their Sovereign, had made extensive explorations on the Upper Peninsula, and published glowing accounts of the abundance of copper, to which later travelers added legends of gold and precious stones. Before them, the Indian tribes, whose stone tools now furnish subjects of inquiry to the archeologist, had wrought rudely upon the deposits which nature had left in a condition so exceptionally pure as not to need, for the production of limited amounts of metal, the intervention of metallurgical processes. The first recorded mining operations on the part of white men were those of Alexander Henry, near the Forks of the Ontonagon, in 1771. As is well known, however, the active development of this region dates from the publication of Houghton's *Geological Report*, in 1841, and the extinguishment of the Chippewa title by the treaty of 1843.

Lead mining in this country may also claim an ancient origin—as we reckon antiquity. As early as 1651, Governor John Winthrop received his famous license to work any mines of "lead, copper, or tin, or any minerals as antimony, vitriol, black-lead, alum, salt, salt-springs, or any other the like," and "to enjoy forever said mines, with the lands, woods, timber, and water within two or three miles of said mines." As he received also a special grant of mines or minerals in the neighborhood of Middletown, Conn., it is not unlikely that the old Middletown silver-lead mine, the date of the discovery of which is not precisely known, was opened by him or his successors. The nickel and cobalt mines near Chester, in Connecticut, once held to be very promising deposits, are also believed to have been originally worked by Governor Winthrop; but nickel was not valuable in those days; and the lead and copper in these ores do not seem to have been abundant. Unfortunately, now that nickel and cobalt are so valuable as to repay amply the cost of ex-

tracting them when they are present in a small percentage only, these Connecticut ores no longer correspond (if indeed they ever did) to the analysis and accounts formerly given as to their niccoliferous character.

The old Southampton silver-lead mine, in Massachusetts, well known to mineralogists, was commenced in 1765, by Connecticut adventurers; but its operations were suspended by the Revolutionary war. Lead mines in Columbia and Dutchess Counties, N. Y., were also worked at an early period; and, no doubt, all over the country occupied or controlled during the war by the American forces, there were small and desultory surface operations, furnishing lead for the use of the army.

The Indians inhabiting the Mississippi Valley before the advent of the whites probably did not understand the metallurgy of lead. Galena has been found in the Western mounds, but, it is said, no lead. In 1700 and 1701 Père Le Sueur made his famous voyage up the Mississippi, discovering, as he claimed, many lead mines. Lead mining was begun in Missouri in 1720, while that country belonged to France, and under the patent granted to Law's famous Mississippi Company. Mine la Motte, named after a mineralogist who came over with Renault, the superintendent, was one of the first discoveries. It has been in operation at intervals ever since, and is now successfully managed by Mr. Cogswell, a member of our Institute, who may, I think, truthfully claim that he has charge of the oldest mining enterprise still active in the United States. The ores yield a small percentage of nickel and cobalt, as well as lead.

It was in 1788 that Dubuque obtained from the Indians the grant under which he mined until the year of his death, where the city now stands which bears his name. The land was subsequently ceded to the United States by the Indians, and the representatives of Dubuque were forcibly ejected.

Such, then, was the condition of our mining industry at the commencement of our national existence. We occupied but a strip of territory on the Atlantic; and even in that limited area we had scarcely learned the nature and extent of the mineral resources to be utilized. Anthracite and petroleum, quicksilver and zinc, were unknown as treasures within our reach. The rapid extension of possession, government, population, and industry over plains and mountains to the Pacific, which has been effected in a hundred years, is but the type of a conquest and progress which has advanced with equal rapidity in every department of human labor, and nowhere

more notably than in the departments of mining and metallurgy. The tables which Dr. Raymond has prepared, and which will be printed to accompany these remarks, show that this country has produced during the century ending with 1875, of gold, about 66,680,000 troy ounces, worth about $1,332,700,000; of silver, about 201,300,000 troy ounces, worth about $261,450,000; of quicksilver, 840,000 flasks, or 64,206,000 pounds avoirdupois; of copper, 200,000 tons; of lead, 855,000 tons; of pig-iron, 40,000,000 tons; of anthracite coal, 351,521,423 tons (the ton in all these cases being 2240 pounds avoirdupois); and of petroleum, 76,594,600 barrels. The product of these leading industries for the year 1875 were: gold, $33,400,000; silver, $41,400,000; quicksilver, 53,706 flasks; copper, 15,625 tons; lead, 53,000 tons; pig-iron, 2,108,554 tons; zinc, about 15,000 tons; anthracite, 20,643,509 tons; bituminous coal, about 26,000 tons; petroleum, 8,787,506 barrels.

In order that a clear idea may be formed as to the relative position now held by the United States in the world of mining and metallurgy, I have selected the production of coal, which is the main reliance for power of all organized industry, and of iron, which is the chief agent of civilization, as the basis of comparison with other nations, using, so far as coal is concerned, the figures given in the 42d Annual Report of the Philadelphia Board of Trade, for the year 1873.*

	Tons.	Per cent.
Great Britain,	127,016,747	46.4
United States,	50,512,000	18.4
Germany,	45,335,741	16.5
France,	17,400,000	6.4
Belgium,	17,000,000	6.2
Austria and Hungary,	11,000,000	4.0
Russia,	1,200,000	0.5
Spain,	570,000	0.2
Portugal,	18,000	—
Nova Scotia,	1,051,567	0.4
Australia,	1,000,000	0.4
India,	500,000	0.2
Other countries,	1,000,000	0.4
Total.	273,704,055	100.0

* I wish to acknowledge for these and other figures relating to coal, my obligations to Mr. R. P. Rothwell, who has freely placed at my disposal the very extensive and elaborate compilations of statistics which are to form the basis of an exhaustive paper by his experienced hand on that subject.

The following estimate, in round numbers, of the world's present production of iron is taken from various sources, and may be considered approximately correct. The figures for Great Britain and France are those of 1874, and the product of the United States for the same year has been taken. For other countries the estimates are principally for 1871 or 1872, except Austria and Hungary, for which the official returns for 1873 have been taken.

The quantities are given in tons of 2240 pounds.

		Per cent.
Great Britain,	5,991,000	45.2
United States,	2,401,000	13.1
Germany,	1,600,000	12.1
France,	1,360,000	10.3
Belgium,	570,000	4.3
Austria and Hungary,	365,000	2.7
Russia,	360,000	2.7
Sweden and Norway,	306,000	2.3
Italy,	73,000	0.5
Spain,	73,000	0.5
Switzerland,	7,000	—
Canada,	20,000	0.2
South America,	50,000	0.4
Japan,	9,000	0.1
Asia,	40,000	0.3
Africa,	25,000	0.2
Australia,	10,000	0.1
	13,260,000	100.0

An examination of these tables will serve to show that in the products which measure the manufacturing industry of nations, Great Britain stands first and the United States second on the roll, and that there is a clear and almost identical relation between the product of coal and the product of iron. The United States now produces as much coal and iron as Great Britain yielded in 1850. We are thus gaining steadily and surely upon our great progenitor, and in the nature of things, as the population of this country grows, must, before another century rolls around, pass far beyond her possible limits of production, and become the first on the International list, because we have the greatest geographical extent, and our natural resources are upon so vast a scale that all the coal area of all the rest of the world would only occupy one-fourth of the space in which, within our borders, are stored up the reserves of future power.

In a hundred years, we have thus reached a point at which for

coal, iron, gold, silver, copper, lead, and zinc, we are independent of the world, with abundant capacity to supply as well our growing wants, as to export these blessings of civilization to other and less favored lands, as soon as our labor and our legislation are adjusted to the conditions which will enable us to compete in foreign markets. One hundred years ago we proclaimed our political independence, and we maintained it by force of arms; we are now in a position to proclaim our industrial and commercial independence, and maintain it by the force of peaceful agencies against friendly competition.

A striking view of this prosperous development is presented by the magnificent mineral collection under the charge of Prof. Blake, in the Government building at the neighboring Exposition—a collection which constitutes the first worthy National Museum of Mining and Metallurgy.

Never was a century of free government celebrated under such favorable conditions, never was free government so justified by the material results it has produced. But let us not conceal from ourselves the fact that mere growth in wealth, mere development in industry, mere increase in population are not the best evidences of national greatness; and unless our progress in art, learning, morals, and religion keeps pace with our material growth we have cause rather for humiliation than for glorification.

"Whatsoever things are true, whatsoever things are honest, whatsoever things are just, whatsoever things are pure, whatsoever things are lovely, whatsoever things are of good report" constitute the real glory of a nation, without which the magnificent material structure which in a century we have reared, will disappear "like the baseless fabric of a vision."

In a hundred years, as I have said, we have reached a point at which, for every one of the minerals and metals named, we are independent of the world, having the capacity to supply our own growing domestic demand, and also to export to foreign lands.

It is not my purpose to trace in detail the steps by which this degree of progress has been achieved. The narration of successive events alone, without any discussion of underlying causes and accompanying effects, would consume far more time than I could command. So far as the leading epochs of the history are concerned, I think they may be fairly summed up in the following mere catalogue:

1. First of all, must be named the erection in Philadelphia, in 1794, of the first steam engine in America. We celebrate this year the centennial anniversary of a greater power than the United States

of America—a wider revolution than our War of Independence. It was in 1776 that James Watt presented to the world the perfected steam engine, all the improvements of which since his day are not to be compared with those which he devised upon the rude machines of his predecessors. In one hundred years, the steam engine has transformed the face of the world and affected to its remotest corners the condition of the human race. Few changes have been so profound; not one in history has been so rapid and amazing. With reference to the special subject now under consideration, if I were asked what elements had most to do with the swift progress of our country, I should answer, freedom and the steam engine. But deeper even than any organized declarations or outward forms of freedom lies the influence of the steam engine, which has been from the day of its birth, in spite of laws and dynasties, and all accidents of history, the great emancipator of man.

2. *Gold Mining in the South.*—Already Jefferson, in his *Notes on Virginia,* mentioned the finding of a lump of gold weighing seventeen pennyweights, near the Rappahannock; and, about the beginning of this century, the famous Cabarrus nugget, weighing twenty-eight pounds, was discovered at the Reed Mine, in North Carolina. But the great gold excitement in the South followed the discoveries in Georgia, from 1828 to 1830. The maximum of production (probably never more than $600,000 in any one year) was from 1828 to 1845, since which time it has declined to insignificance, though a few enterprises, both in hydraulic and quartz mining, are now actively prosecuted.

3. *The Opening of the Anthracite Coal Fields and the use of Anthracite in the Blast Furnace.*—The first of these events practically dates from the year 1820, although some anthracite found its way to market much earlier, and the second from the year 1839. The latter was followed by the development of the vast anthracite iron industry, which has contributed so much to the prosperity of Pennsylvania. The connection between anthracite and civilization was long ago pointed out by Sir Charles Lyell, in connection with his visit to this country, when he observed in this State, and in this very city where we now stand, the strange phenomenon of a vast manufacturing population, dwelling in neat houses and able to keep themselves and their houses clean. This smokeless fuel is a great moral and æsthetic benefactor. It has also proved specially useful in metallurgy—one process at least, the American zinc-oxide manufacture, being impracticable without it, and in war no one will deny

its superiority who remembers how our cruisers burning anthracite, and hence not traceable at sea by their smoke, were able to spy and pursue the blockade-runners, whose thick clouds of escaping bituminous smoke betrayed them. A table of the production of anthracite is given herewith; and some further observations concerning its control and management will be appropriate under another head of my remarks.

4. *The Use of Raw Bituminous Coal in the Blast Furnace.*—This was introduced in 1845.

5. *The Development of the Copper Mines of Lake Superior*, beginning in 1845 and increasing slowly but steadily to 1862, when about eight thousand tons of ingot copper were produced; then declining for some years, to recover in 1868 and 1869 its lost ground, and since the latter year, by reason of the great production of the Calumet and Hecla Mine, to attain an unprecedented yield. The tables of copper production for the United States, herewith given, show that our present product is not far from sixteen thousand tons, of which three-fourths must be credited to the Lake Superior mines.

6. *The Discovery of Gold in California*, in 1848, or rather its rediscovery, since it had previously been known to both the natives and the Jesuit missionaries, and also to hunters and trappers. The wonderful direct and indirect results of this event have been too often the theme of orators, historians, and political economists to need a further description from me. Its direct result in the way of mining was the rapid exploration of the Western territories by eager prospectors, and the successive development of placer-mines in nearly all of them. It is difficult to fix the dates of these beginnings; but we may assume with sufficient accuracy that gold mining practically began in Oregon in 1852, in Arizona in 1858, in Colorado in 1859, in Idaho and Montana in 1860. With the completer exploration of the country, and the decline of the placer-mines, stampedes have grown less frequent and extensive than in the earlier days. There is scarcely any corner of the country left, except the Black Hills of Dakota, which has not been ransacked sufficiently to show whether it contains extensive and valuable placer deposits; and those districts which present accumulations of gold in such a way as to offer returns immediately to labor without capital have been already overrun. The principal reliance of our gold-mining industry for the future must be quartz and hydraulic or deep gravel mines. These may be expected to maintain for years to come their present rate of production, if not to increase it. In the table of gold production,

herewith given, there is, it is true, a falling off of late years; but this is to be attributed to the placer-mines.

7. *The Commencement, about* 1851, *of Regular Mining Operations at the New Almaden Quicksilver Mine, in California.*—The production of this metal in the United States has been thus far confined to the State of California; and it will be seen from the table of the production of the New Almaden mine, that it has always furnished a large, though of late a waning, proportion of the grand total for the country.

8. The middle of the nineteenth century was crowded with important events in metallurgy and mining. It was in 1856 that Mr. Bessemer read his paper at the Cheltenham meeting of the British Association for the Advancement of Science, which inaugurated for both continents the age of steel. Within sixty days after that event an experimental Bessemer Converter was in readiness at the furnaces of Cooper & Hewitt, at Phillipsburg, New Jersey. But the experiment was not carried far enough to demonstrate the value of the newly-proposed process, and it was left to the late John A. Griswold and his associates to introduce and perfect this wonderful method in the United States. I speak more briefly on this point than its far-reaching importance deserves; but in the presence of one whose acquaintance with it is so profound, and whose services in relation to it have been so brilliant as those of our honored president, Mr. Holley, and of so many gentlemen as I see before me who are worthily associated with him in its glorious history, I could afford to be silent altogether.

9. *The Commencement of the Hydraulic Mining Industry.*—The position of the auriferous slates and quartz veins, on the west flank of the Sierra, with the precipitous mountains behind them, and the broad plain before, has favored exceptionally the formation of deep auriferous gravels in which California far exceeds any other known region. And the same topographical features furnish the two other prime requisites of hydraulic mining, namely, an abundant supply of water and a sufficient grade of descent to permit the use of flumes and the escape of tailings. These advantages the keen-witted miners of the Pacific coast were quick to make available; and I think we may set down the invention of hydraulic mining, which occurred, I believe, about 1853, as an epoch in the progress of American mining. It has given us an entirely new and original branch of the art, involving many ingenious hydrodynamic and hydrostatic contrivances; and it has certainly made possible the exploitation of thousands

upon thousands of acres of auriferous gravel which could not have been profitably handled in any other way. The mountain torrents of the Sierra, caught on their way to the Pacific, have been forced to pause and do the work of man. The same agencies that buried the gold among the clay and pebbles of the river-beds are now made to strip the covering from it and lay it bare again. The hydraulic mines produce, at present, not less than $10,000,000 or $12,000,000 annually; and many enterprises of this kind which have been prosecuted through years of expensive preparation, and are now just beginning to touch their harvests of profit, will add henceforward to the product. I may mention as an illustration the extensive operations of the North Bloomfield and its two allied companies in California, which have expended in works $3,500,000, and will have six deep tunnels, aggregating over 20,000 feet, and canals supplying 100,000,000 gallons of water daily.

10. We must turn for a moment to the East again, to note the commencement of iron mining at Lake Superior, about the year 1856. The extraordinary pure and rich ores of the upper peninsula of Michigan now find their way, to the extent of a million of tons per annum, in fleets of vessels across the lakes to Cleveland, and are thence distributed to the furnaces of Ohio and Pennsylvania. The similarly pure Missouri ores have built up in like manner their own market. The growth of the Lake Superior iron business is shown in the accompanying table.

11. The next great event in the history of American mining was the discovery, in 1859, that the Comstock lode was rich in silver. This opened an era of activity and speculation which has scarcely ceased since that time. Single districts have been subjected to fluctuating experiences, passing from the first enthusiasm through all the stages of hope to reaction and despair; but though the fortunes of each have risen and fallen like the changing tide, it has nearly always been high water somewhere. Thus we have had a succession of favorites in the way of silver-mining districts, each one crowding its predecessor out of the public notice. Of these the following list includes the most permanently productive: In Nevada, the Unionville, Reese River, Belmont, White Pine, Eureka, Esmeralda, and Pioche districts; in California, the argentiferous district of Inyo County; in Idaho, the Owyhee district; in Utah, the Cottonwood and Bingham districts; in Colorado, the silver districts of Clear Creek, Boulder, and Summit Counties, to which the latest favorite, the San Juan region, may be added. I have named those localities

in which mining industry is still active and flourishing. There is a longer and a sadder list, the funereal effect of which I will not intrude upon this festive occasion. But it ought to be remarked, that the apparent failure and abandonment of many districts heretofore does not argue their lack of prospective value. It is, on the contrary, amazing that under the adverse conditions surrounding the industry of mining in regions "remote, unfriended, solitary"—though not "slow"—so many communities should have succeeded in taking permanent root. Too much is expected of this industry when it is required to supply the lack of labor, food, transportation, government, and the organized support which in settled societies all the trades and occupations give to each other. Pioneer work is full of peril and of waste; and in view of the wonderful results achieved by our pioneers in mining, it ill becomes us to sneer at the losses and failures which constitute the inevitable cost of such conquests. When the battle has been gloriously won, and the spoils of victory are ours, we do not greatly mourn over the number of bullets that may have been fired in vain.

But through all the vicissitudes of silver mining in other districts, the Comstock mines have maintained their place, an instance of rapid exploitation, and of aggregated wealth of production unexampled in history. Here, too, there have been intervals of failing hope; but a new *bonanza* has always made its appearance before the resources at hand were entirely exhausted; and we have seen extracted from the ores of this one vein, during the past fifteen years, the round sum of $200,000,000 in gold and silver. Dr. Raymond, in the table herewith given, assumes the product of gold to have been (on the authority of Mr. Hague) about 40 per cent. of the entire value. We have, therefore, from the Comstock mines during the period named, $80,000,000 gold, and $120,000,000 silver.

The swift development of these mines, and the active commencement, about the same time, of deep quartz mining operations in California led to a remarkable progress in mining machinery, and to the perfection of two distinctively American processes. I refer to the California stamp mill and amalgamation process for gold, and the Washoe pan-process for silver. Neither of these is so novel in principle as the hydraulic process of gold mining already mentioned; but both of them have received the peculiar impress of an ingenuity and mechanical skill, partly innate in our national character, and partly the product of the stern pressure of economic necessities. Into the fruitful field of further metallurgical improvements born of

our Western mining industry—or adopted by it—such as the Blake rock-breaker, the Stetefeldt roasting furnace, the Brückner cylinder, the Plattner chlorination, and many others less widely known, I cannot enter here. Our people have advanced in this line with headlong energy, and accomplished great results—at great expense. Much, undoubtedly, remains to be done; and it may be hoped that future progress will be equally rapid, but less costly. The introduction, three or four years ago, of the smelting processes of Europe for the treatment of the silver ores of the West, is a striking and encouraging instance of the quickness of our mining communities to seize upon the advantages of experience elsewhere, as soon as they are brought to notice. The ignorance which has led to many disasters in such enterprises, was not voluntary or obstinate. Give our people light, and they do not keep their eyes shut. I am assured that already the smelting works of the West present many features of interest and suggestiveness even to the eyes of our skilful colleagues from abroad.

12. I may be permitted, in closing this imperfect review, to refer to the great improvements in mining machinery, in rock-drilling, in explosives, in the use of gaseous fuel, in the construction and management of blast furnaces, puddling furnaces, rolling mills, and other branches of the iron manufacture, which have crowded upon us during the last ten years. It is impossible here to give even an enumeration of them which shall do them justice. They have been worthily commemorated in many papers before the Institute. With regard to one of them, the Martin process for the manufacture of open-hearth steel, I may speak with some personal satisfaction, since I had the privilege of introducing it into this country, after studying its merits in 1867 abroad. I am convinced that it has a great future, as the ally, if not the rival, of the Bessemer process.

Returning now to the contemplation of the general field over which we have passed, we may inquire what the Government of the United States has done, with regard to the mining industry. Other nations have elaborate mining codes and bureaus of administration. In comparison with these, the meagerness of our governmental supervision of mining is remarkable; yet, in view of the progress I have sketched, may it not be possible that our system has been on the whole the best for us? Certainly a complicated mining code like that of Spain and Mexico, whatever it may have brought to the coffers of the State, seems to have conferred, in centuries of operation, little benefit upon the people.

The common law of England is the foundation of our jurisprudence in this, as in so many other respects. According to that law, as laid down in a noted case in the reign of Elizabeth, all gold or silver ores belonged to the crown, whether in private or public lands; but any ores containing neither gold nor silver belonged to the proprietor of the soil. Apart from the claims of the crown, the property in minerals is, according to the common law, *prima facie* in the owner of the fee of the land, but the property in minerals, or the right to search for them, may be vested in other persons by alienation, prescription, or custom. Since the two latter rights require an origin beyond the time of legal memory, they are practically out of the question in this country. The crown right to the precious metals, as declared in the case referred to, was a survival or remainder of the royalty claimed in ancient times by the sovereign over all minerals. This sweeping claim, born of the despotisms of the Orient and made the subject of much conflict among emperors, feudal lords, and municipal authorities during the middle ages, dwindled at last till it covered only gold and silver. But it disappeared entirely from English America, for the simple reason that there was no private land ownership in this country, and the sovereign of England claimed, by right of discovery, soil and metals alike, barring only the Indian title, which it was his exclusive privilege (or that of his authorized representatives or grantees) to extinguish. After the Revolution, the United States succeeded to the rights of the British crown, and by the treaty of peace and the subsequent cessions by the different States of their colonial claims upon the public lands, the federal government became possessed of a vast domain over which, after extinguishing the Indian title, it had complete control. In the territories subsequently acquired from France and Spain, the United States assumed the rights and obligations of those sovereigns; and this circumstance, particularly in the adjustment of Spanish mineral and agricultural grants, has caused some apparent variations from the general policy. But it is sufficiently accurate to say that at the present time, throughout the country, the owner of the fee, or the party who has obtained from him by lease or purchase the mineral right, has supreme control. The mining legislation of the United States, therefore, is simply a part of the administration of the public lands; and for this reason it is executed by the Commissioner of the General Land Office.

In 1807 an act was passed, relating primarily to the lead-bearing lands of Illinois. They were ordered to be reserved from sale, and

leased to miners by the war department. The leases covered tracts at first three miles square (afterward reduced to one mile), and bound the lessee to work the mines with due diligence and return to the United States 6 per cent. of all the ores raised. "No leases were issued under this law," says Professor Whitney, "until 1822, and but a small quantity of lead was raised, previous to 1826, from which time the production began to increase rapidly. For a few years the rents were paid with tolerable regularity; but, after 1834, in consequence of the immense number of illegal entries of mineral land at the Wisconsin Land Office, the smelters and miners refused to make any further payments, and the government was entirely unable to collect them. After much trouble and expense, it was, in 1847 finally concluded that the only way was to sell the mineral land, and do away with all reserves of lead or any other metal, since they had only been a source of embarrassment to the department."

Meanwhile, by a forced construction (afterwards declared invalid) of the same act, hundreds of leases were granted to speculators in the Lake Superior copper region, which was, from 1843 to 1846, the scene of wild and baseless excitement. The bubble burst during the latter year; the issue of permits and leases was suspended as illegal, and the act of 1847, authorizing the sale of the mineral lands, and a geological survey of the district, laid the foundation of a more substantial prosperity.

This policy of selling the mineral lands has been that of the government ever since. But it has necessarily been modified in the West by the peculiar circumstances under which that region has been settled. Before lands can be sold they must be surveyed; and before they can be sold as mineral lands, their mineral-bearing character must be ascertained. Our miners and explorers overran and occupied the Pacific slope in advance of the public surveys. They built cities that were not shown on any map; they cut timber, turned water-courses, dug canals, tunneled mountains, bought and sold their rights to these improvements under laws established by themselves, and enforced by public sentiment only. For nearly twenty years the government looked on, without asserting its dominant ownership of the public lands; and when by the acts of 1866, 1870, and 1872, and other minor enactments, a general system was created, it was necessary to recognize as far as possible the rights which had grown up by general consent, and to seek only to give to them certainty, practical uniformity, and reasonable limitations. It is not my purpose to discuss in detail the mining laws of the United States, or to trace the curiously complicated origins of the local customs on which

they are largely based. Suffice it to say that the system recognizes the English common law principle, that the mineral right passes with the fee to the lands; so that, in the words of the commissioner (July 10th, 1873) "all mineral deposits discovered upon land, after United States patent therefor has issued to a party claiming under the laws regulating the disposal of agricultural lands, pass with the patent, and the Land Office has no further jurisdiction in the premises."

But the principle is also recognized that the mineral right may be separated from the fee by the owner, whether he be an individual or the United States; and this principle is curiously applied in the form of patents for mining claims upon lodes, which, following the form of the possessory title, grant to the patentee the right to follow all veins, the top or apex of which lies within the exterior boundaries of his claim, downward to any depth, though they pass under the surface of the land adjoining.

As the size and the price per acre of the tracts sold under the agricultural laws are different from those to which the mining laws apply, and as, under the homestead law, a certain amount of agricultural land may be obtained without any payment, it is evident, that no known mineral deposits can be acquired under the agricultural laws; and this reservation is enforced both in the preliminary proceedings and in the patents finally issued under those laws.

With regard to the mineral lands, however, it is certain that the patent for a claim carries with it both the fee of the land and also a mineral right, though not the same mineral right as is contemplated by the common law; since it is enlarged on the one hand by the permission to follow mineral deposits beneath the surface of adjoining land, and limited on the other hand by the operation of the same permission in favor of the adjoining owner. The latter limitation is incorporated in agricultural patents also, and may become operative whenever they adjoin mining patents.

Previous to the application for a patent, the law permits free exploration and mining upon the public lands to all citizens and those who have declared their intention to become such. The rights of this class of miners, under what is known as the possessory title, are regulated by local laws and customs, subject only to a few simple conditions, which the United States enforces upon all, and which chiefly concern the maximum size of individual claims, the definite character of their boundaries and landmarks, and a certain quantity of labor which must be bestowed upon them annually, in order to maintain possession. I will not pause to state the different features which these conditions present for lode and placer claims. It is

sufficient to say that the miner, conforming to them, and thus maintaining his possessory title, may, after a certain expenditure, and upon due application, survey, and advertisement, in the absence of any valid opposing claim, perfect his purchase from the Government, receive his patent, and be thereafter free from the necessity of performing any given annual amount of labor to hold his claim. There are features in the present law concerning the rights of prospecting tunnels which seem both obscure and unwise; and some serious questions remain to be settled as to the precise meaning of the law in these and other respects; but these we must pass by.

Looking at the legislation on this subject as a whole, we see that it is confined to one department—that of title. The whole system is devised to facilitate the purchase of the mines by citizens. They are freely permitted to work them experimentally, but it is made their interest to buy them. No inspection, no police regulation, no technical control, is exercised by the Government.

Turning to the State and Territorial Legislatures, we find that they have, in some cases, provided for inspecting mines, in the interest of the safety of workmen. Perhaps the best law of this kind is that of Pennsylvania, in which State the peculiar perils of coal-mining have forced the Legislature to take measures of protection. But we find nowhere such a technical control of mining as is exhibited in many European States, where the Government requires of the miner that he shall not waste wantonly or ignorantly the resources which, once exhausted, will never grow again. Our people waste as much as they like, and no one interferes. Admitting that this is an evil, it still remains a matter of doubt how far, under the circumstances of our particular case, the supervision of authority could remedy it. For my own part, though inclined to restrict as far as possible the functions of government, I am not disposed to say that for so great an end as the conservation of the mineral wealth of the country, it may not properly enforce some measures of economy, with as good right as it may forbid the reckless waste of timber or the slaughter of game out of season. But, in our nation, at least, governmental interference is the last resort, and a poor substitute for other causes, which, in the atmosphere of freedom and intelligence, ought to be effective. We are, perhaps, in our material career as a nation, like the young man who has "sown his wild oats," and now, by mature reflection and the lessons of experience, is likely to be better restrained than by the hand of parental authority.

Permit me, in drawing my remarks to a close, to suggest two agencies which seem to me to be co-operating already, and to open

still wider future prospect, for the steady social and economical improvement of our mining and metallurgical industry.

The first of these is the spread of knowledge on these subjects throughout the country. Under this head we must recognize the great importance of that series of explorations of our great Western domain, which was recommended by Mr. Lincoln, with sublime faith in the salvation of his country, in the midst of the civil war, and which has been, by the liberality of the Government, prosecuted under various departments ever since. I need hardly make special mention, in addition, of the reports of the Commissioner of Mining Statistics, which have appeared annually since 1866, and have reflected upon our own community the light of the gathered technical knowledge of the world, while they have in turn exhibited to the world the resources and the progress of America. Such works as these, together with the technical periodicals and the occasional volumes, translated or original, which have come from the American press, have contributed already a great deal to the education of our mining communities. The government has not done too much in this direction; but it seems to me that it should continue this most necessary and proper work in a more systematic and uniform way. There ought to be no conflict of authorities, no duplication of work, no unnecessary expenditure of labor and money in the face of a task so great.

Next in order, I may rank the influence of the technical schools. The number of these has rapidly increased during the past ten years; and I venture to say that many of them compare favorably, in theoretical instruction at least, and several of them in the apparatus of instruction, with the famous schools of the old world. The Massachusetts Institute of Technology, at Boston; the School of Mines of Columbia College, at New York; the Sheffield Scientific School of Yale College, at New Haven; the Stevens Institute of Technology, at Hoboken; the Pardee Scientific Department of Lafayette College, at Easton; the excellent school at Rutgers College, under the direction of Prof. Cook; the new Scientific Department of the College of New Jersey; the School of Mining and Metallurgy of Lehigh University, at Bethlehem; the School of Mining and Practical Geology of Harvard University, at Cambridge; the Scientific Department of the University of Pennsylvania, in this city; the School of Mines of Michigan University, at Ann Arbor; the Missouri School of Mines and Metallurgy, at Rolla; the Polytechnic Department of Washington University at St. Louis; and the similar department of the University of California, at Oakland; and perhaps some

others which I have omitted to name—this is a list of schools for instruction in the sciences involved in mining and metallurgical practice, of which we need not be ashamed. What our schools undoubtedly need, is a more intimate relation with practice. But this theme I need not touch. It has been ably and amply discussed at the joint meeting last night of the two bodies most fully aware of all its bearings.

One more agency of the spread of technical knowledge deserves special mention. I refer to the influence of societies like the Institute of Mining Engineers. The five years' activity of this Institute has impressed upon the professions which it represents a spirit of union, an enthusiasm of progress, a mutual recognition of the claims of theory and practice, which cannot be too highly estimated. Perfect our schools as much as we may, the association of the young engineer with experienced engineers, the contact of his mind with mature minds, their recognition of his merit, their correction of his errors, constitute the necessary supplement to the school-training. The average man, at least, should not be left to wrestle with his professional career alone. He will make better progress and take more pleasure in it, if he calls to his aid the element of social sympathy, and the intellectual reinforcement expressed in the proverb, "many heads are better than one."

One further consideration, and I have done. The effect of growing intelligence and knowledge in improving our methods of industry would come short of some great ends if it operated only through the self-interest of the individual. Many reforms are beyond the power of the individual; some are not even to his interest. Thus the miner under a possessory title on a gold-bearing quartz vein in Colorado may know that with a greater investment of capital he could manage to reduce his losses of gold in extraction; but the capital may be wanting; or, he may know that by robbing the mine of its richest ores only, and allowing it to cave, he is probably destroying more valuable resources than he utilizes; but the mine is only temporarily his, and he prefers quick gains to permanent ones. So long as the anthracite lands of Pennsylvania were leased to countless small operators, who paid royalty only on the coal which they sent to market, it was useless to explain to them that they wasted a third of the coal in the ground, and another third in the breaker, or that they ruined thousands of acres of coal-beds, overlying those which they recklessly worked. If there were no natural remedy for this wicked waste of the reserved force upon which the future prosperity and comfort of mankind depend, it would be the highest duty

of Government promptly to take into its own hands the direction and management of the mines of coal which society holds in trust for the future; but already it is easy to detect the operation of a new social law developed within the memory of man, but the fruit of the preparation of the ages during which society has been slowly built up, and matured into its present form and conditions.

To the philosophic observer, the controlling law which runs through the whole history of man, down to the present century, is the law of dispersion, diffusion, distribution, the centrifugal social force, so to speak, which by its irresistible power has tended not merely to scatter mankind over the face of the habitable globe, but through what are termed civilizing and Christianizing agencies to place communities and individuals upon the common plane of equal rights in the domain of nature and before the law.

From the time of the confusion of tongues at the Tower of Babel, through the long history of the early Oriental Empires, which reduced society to the rule of order and then broke up into fragmentary political organizations, retaining, nevertheless, the principles of cohesion acquired by bitter experience; through the Greek and Roman imperial political structures upon which were ingrafted the civilization and the religion which their downfall made the common heritage of the northern barbarians who came for destruction, but were themselves transformed into the apostles of a more liberal and enlightened social organization, this law of dispersion has never ceased to exercise its power and its supremacy. The very inventions of man are only so many proofs of the unceasing operation of this law. In warfare, gunpowder and firearms merely enlarged the area over which it was possible to carry on military operations; the magnetic compass only widened the field of commerce; the printing-press and the telegraph are merely agencies for the diffusion of thought; the steam engine is but a means whereby it becomes possible to establish local industries in every part of the habitable globe; and the canal and the railway are essentially distributers of the products and the wealth of the human race.

Although there is an impression abroad that this age is one of growing concentration of property, no man can study the history and the facts of the development of society without coming to the conclusion that at no period has there been so general and equal a distribution of rights and property as in the present age. The destruction of the feudal system was, in reality, the establishment of a new and better theory, in regard to the ownership of land, which has borne its legitimate fruits in the subdivision of estates in France,

through the convulsions of a revolution; in the more general distribution of landed property in Germany, and in that steady, remarkable, and successful agitation in England, which is now showing its results in the limitation of entail, the simplification of transfer, the enlargement of the suffrage, and the acquisition of small freeholds, whereby political power is being slowly but surely transferred from the great landholders to the middle classes of the most powerful and compact political organization which the world has ever seen.

While, then, there is thus an unmistakable progress in the world towards a juster and more general distribution of the control of the resources of nature and of the fruits of human industry, the present century has, undoubtedly, developed a new and remarkable centralizing tendency, which might be denominated the centripetal industrial force. I speak of the application of the corporate principle to the management of industrial enterprises, producing a concentration of property and management through the diffusion of ownership. Under the corporate system, the number of owners may be unlimited, but the management is necessarily confined to a few hands. It is the political idea of representation applied to industrial enterprises; it is the common wealth in its industrial, and not its political sense, which is concentrated for the material wants and progress of the human race. Now, this law of universal ownership, under limited management, heretofore applied with marked success during the latter half of the present century to great manufacturing establishments in this country, and of late in Europe, and of necessity to railroads everywhere, has at length, by slow but irresistible steps, taken possession of the great mining enterprises of the United States, and to-day has its strongest and most interesting development in the anthracite coal region, which may be said to be monopolized by six great corporations, administered by a very small number of able officers representing a vast body of owners who rely upon steady but not excessive dividends for their support. It is the fashion to denounce these corporations as monopolizers, but it is only the thoughtless who do not investigate below the surface, who take this view of what is really the most interesting and suggestive application in our day of a powerful and irresistible force originating in the very heart of the social fabric. The monopoly is not the monopoly of ownership, for everybody is free to buy and sell, and there is no day when a man with money may not, at its value, procure a share in these enterprises. And no one familiar with business will pretend that the profits have been out of proportion to the cost and the risk of the undertakings, and no more conclusive answer, to any complaint

on the score of monopoly can be made, than that to-day the shares in these corporations, in many cases, are selling below the original money cost. These corporations are, in fact, not the creators, but the outgrowth of a new and beneficent principle, which has begun to assert itself in society, and will continue to grow in power until the end of time. This principle is the practical association of diffused capital, through the agency of corporate organization, with labor, for the promotion of economy, for the improvement of processes, and for the general welfare of mankind.

The capital is derived from innumerable sources, just as the little rills, finally, through streams and rivers, constitute the great ocean. The laborer himself may thus be the capitalist, and the capitalist may thus be the laborer, each taking his share of that portion of the fund which is appropriated to labor and to capital, and often in a double capacity taking a share from both.

In its perfect and ultimate development it embodies the Christian idea of "having all things in common," yet "rendering unto Cæsar the things that are Cæsar's."

The rate of profit which may be derived from these great enterprises, subject as they are to the scrutiny, criticism, and judgment of the public, in an age when nothing escapes notice, and all rights and property are virtually subordinated to the popular will, can never be excessive, for two reasons: on the one side the public will inevitably demand lower prices for an article of primary consequence in every household, and these corporations, creatures of the public will as they are, could not successfully resist such a demand, based upon excessive or unreasonable profits. On the other hand, whenever the dividends rise above a reasonable rate of compensation, the laborers engaged in the production of coal, from whom these profits cannot be concealed, will justly claim, and rightfully secure, a larger share of the fruits of their labor. The checks upon any unreasonable exercise of the power conferred by the ownership under limited management of the anthracite coal-fields, are in reality so powerful that the public have nothing to fear from this cause, but the corporations have rather reason to dread that they may not have justice at the hands of the public and the working classes. This justice they can only hope to secure by the wisest, best, and most economical management and administration of the property they control, and whatever profits they may hereafter derive and be allowed to divide among the owners, will be rather due to the economies which they may be able to introduce, whereby the article is furnished at

the lowest possible rate, than to any fancied monopoly which they may have in the coal itself, or in its transportation to market.

Already, by the application of adequate capital, guided by the largest experience and the highest technical skill, the anthraeite coal-mines, from being worked in a wasteful and extravagant manner, are being rapidly put in the best possible shape for the economical delivery of coal at the surface, and for the preservation of every portion of the store upon which the future value of the property must depend. But besides economy in mining and care in preserving, there must be regularity and stability in the operations of the mine. There can be no real profit where these operations are subject to constant interruption, caused by strikes or other artificial impediments. The loss of interest on the plant at the mines, and in the lines of transportation caused by any serious stoppage to the works, would, of itself, be sufficient to render investments of this kind unprofitable. Hence the out-put must be regulated and proportioned to the wants of the market. But this regulation must be continuous and not spasmodic. To enable this to be done, large stocks of coal must necessarily be kept on hand, in order that any sudden demand may be properly met without any serious increase in price; and in dull times the accumulation and restoration of the stocks will give steady employment to the miners, to whose families any cessation of work is a calamity of the most serious character, and to society an unmitigated evil. To insure continuous operations, the best relations must exist between the corporate owners and the laborers in their employ. It is notorious that throughout the coal regions these relations have been of the most unsatisfactory character, resulting, at often-recurring intervals, in strikes and lock-outs, which have no redeeming feature, but, on the contrary, have raised the price of coal to the consumer, have impaired the dividends of the owners, and have reduced the working men and their families to a condition of suffering and demoralization, appalling to every well-wisher of his race. It is fortunate, therefore, that the interests of all classes concur in the prevention of these destructive and demoralizing collisions, and that the owners of the property, for their own self-protection, will be driven to remove the causes which have produced them. It is idle for them to expend their capital for the best machinery, for the highest skill, for the most economical transportation, unless they can, at the same time, insure a continuous production from a contented laboring population.

This they have it in their power to do. If the same spirit of sacrifice which has sent out our missionaries into every heathen land,

had been shown in the coal regions, and the same efforts had been made to establish and maintain the school-house, the church, and above all the Sunday-school, which have borne such fruits elsewhere in this broad land; if the hospital for the sick, and the comfortable refuge for the unfortunate had been carefully provided; if reading-rooms and night-schools, and rational places of amusement had, from the outset, been maintained for a growing and restless population, the coal regions to-day might have been a paradise upon earth instead of a disgrace to civilization. And here it is that this new power of concentrated management can exert itself with sure and absolute success. The appropriation of a few cents per ton on the coal mined to the work of improving the moral and intellectual conditions of the miners and their families will, in a time incredibly short, change the whole face of society in the coal regions.

To be effective, however, this consecration of a fixed amount on each ton of coal sent to market must be as absolute and final as that portion of the proceeds which is devoted to pumping the mines, or driving the gangways. It must not come from grace, but from a sense of duty involved in the ownership of property, and dictated by a wise regard for its preservation and permanent value. Even if this percentage were added to the price of the coal the addition would not be grudged by the public; but in fact no such addition could possibly occur, as there is no surer way of promoting economy in the cost of production than by improving the social condition, the self-respect, and the intelligence of those who are engaged in the work of production, which thus becomes continuous and systematic. Until the great companies thus recognize the duties, the responsibilities, and the opportunities for good, which are offered by the new social development which has rendered their existence a necessity as well as a possibility, they must not complain that they are regarded with distrust, and as enemies, both by the public which consumes their products, and by the working classes who see in them only grasping employers without a conscience. What individual owners could not do, it is easy for these great companies to put in practice; but the effort must be as earnest and serious as is the business of producing the coal and getting it to market. The very best talent must be secured for the organization and management of the various agencies necessary for the moral, intellectual, and social improvement of the working classes, who must be themselves associated in the administration of the fund created and expended for their benefit. Five cents per ton would produce an annual revenue of over $1,000,000 applicable to this necessary and noble use, and five years

of its intelligent and conscientious administration would convert what in some regions has been aptly termed a "hell upon earth" into a terrestrial paradise which would be the pride and the glory of the new world.

What more fitting celebration of the Centennial year of American Independence could be possibly suggested or devised, or how could the advent of the incoming century be better signalized, than by the foundation on the part of the great anthracite coal companies of a new department in their administration for the moral, mental, social, and physical improvement of the workingmen and their families, and by the appropriation of a fixed charge on coal for this purpose. Let each of them select a well-paid and competent agent to devote himself to this work; let the various agencies be wisely organized and surely perfected, and there will be realized one of the greatest triumphs of that gospel which proclaimed, "Peace on earth, and good-will towards men." The example thus set will soon extend itself to other industries, and to every branch of business which can adapt the corporate principle of the concentration of management through diffusion of ownership, the result of which will be that the strange phenomenon, now felt throughout the civilized world, of a general glut of products in the face of general want of them, will never again be witnessed; because, when the working classes, through the diviner agencies of Christian effort, shall have constant employment, and adequate compensation, the sure results of general enlightenment and a cultivated conscience in the use of property, the power of consumption, now so far in arrear, will surely overtake the power of production, and re-establish the equation which nature intended to subsist between them. Thus may be realized that Christian commonwealth which has been the dream of the patriot, the philanthropist, and the statesman, in all ages, in which every man who is willing to work shall find employment, and in which the products of industry will be so distributed that every man shall feel that he has received his fair share of them; in which there will be neither abject and hopeless poverty on the one hand, nor superfluous riches on the other, because the problem of how to distribute capital through the concentration of management will have been fully solved and be thoroughly comprehended by all classes in the community; in which the quaint questions put by Sir Thomas More, three hundred and sixty years ago, will at length have been answered, and his suggestive commentary thereon have lost its significance.

."Is not that government both unjust and ungrateful, that is so prodigal of its favors to those that are called gentlemen or gold-

smiths, or such others who are idle, or live either by flattery, or by contriving the arts of vain pleasure; and on the other hand takes no care of those of a meaner sort, such as ploughmen, colliers, and smiths, without whom it could not subsist?

"But after the public has reaped all the advantages of their service, and they come to be oppressed with age, sickness, and want, all their labors, and the good they have done is forgotten, and all the recompense given them is, that they are left to die in great misery. The richer sort are often endeavoring to bring the hire of laborers lower, not only by their fraudulent practices, but by the laws which they procure to be made to this effect, so that though it is a thing most unjust in itself to give such small rewards to those who deserve so well of the public, yet they have given those hardships the name and color of justice, by procuring laws to be made for regulating them."

Although I quote from the *Utopia*, let it not be supposed that there is anything Utopian or impracticable in the proposition which I have advanced. It seems to me to be the next great step to be taken for the amelioration of the condition of mankind. The law of diffusion which thus far has governed the progress of the human race toward a higher and better plane of civilization, has at length made an effective lodgment in the domain of capital, whereby it is rendered capable of infinite division without impairing, but in effect improving the economy and force of its administration. The reproach that "corporations have no souls," must, and will, next be removed, so soon as the beneficent possibilities inherent in these agencies shall be generally recognized, and those who are called to the management shall see that because capital is aggregated, the primary law on which all property rests, that it is a trust to be administered for the public good, loses none of its force, but can, in reality, only assert itself in all its vigor when concentrated management is brought to bear upon great aggregations of capital. Man did not become a "living soul" until God breathed into him the breath of life. So corporations are mere machines until they are inspired by the associated conscience of society, to which they can give ready and effective expression, and I look for this expression first from the great coal companies, because their property and their peculiar organizations make it easy as well as profitable for them to put in practice the fundamental idea, that a fixed portion of the proceeds of industry should be invariably devoted to the social improvement of those who labor directly for its development.

If the seed here dropped should take root, as I pray and believe

it will, then indeed will the country and the world have reason to rejoice at the industrial development of the last hundred years, and the celebration of this Centennial be the dawn of a better day for the patient sons of toil, who, let it be confessed, with all frankness and humility, have not yet been endowed with their fair share of the good things of this goodly earth.

Table of Production of Leading Metals and Minerals in the United States during the First Century of National Independence. Prepared by R. W. RAYMOND.

	Anthracite, in tons of 2240 lbs. avoir.	Pig-iron, in tons of 2240 lbs. avoir.	Lead, in tons of 2240 lbs. avoir.	Copper, in tons of 2240 lbs. avoir.	Quicksilver, in flasks of 76½ lbs. avoir.	Gold, in dollars, U. S. coin.	Silver, in dollars, U. S. coin.	Petrol'm, in barrels, of 42 gallons.
1819	18,000*	.....	.....	.....	.....	.....	.....	.....
1820	1,965	.....	.....	.....	.....	.....	.....	.....
1821	3,273	.....	.....	.....	.....	.....	.....	.....
1822	4,940	.....	.....	.....	.....	.....	.....	.....
1823	9,023	.....	.....	.....	.....	.....	.....	.....
1824	13,641	.....	4,432*	.....	.....	.....	.....	.....
1825	38,499	.....	1,281	.....	.....	.....	.....	.....
1826	54,815	.....	1,771	.....	.....	.....	.....	.....
1827	71,167	2,178,239*	3,927	.....	.....	.....	.....	.....
1828	91,914	130,000	7,815	.....	.....	.....	.....	.....
1829	133,203	142,000	7,824	.....	.....	.....	.....	.....
1830	209,634	165,000	7,163	.....	.....	.....	.....	.....
1831	230,320	191,000	6,646	.....	.....	.....	.....	.....
1832	448,171	200,000	8,888	.....	.....	.....	.....	.....
1833	592,210	218,000	9,767	.....	.....	.....	.....	.....
1834	456,859	236,000	10,552	.....	.....	.....	.....	.....
1835	678,517	254,000	11,696	.....	.....	.....	.....	.....
1836	825,729	272,000	14,216	.....	.....	.....	.....	.....
1837	1,039,241	290,000	11,994	.....	.....	.....	.....	.....
1838	873,013	308,000	13,512	.....	.....	.....	.....	.....
1839	957,436	326,000	15,539	.....	.....	.....	.....	.....
1840	1,008,220	347,000	15,000	.....	.....	.....	.....	.....
1841	1,115,045	290,000	18,171	.....	.....	.....	.....	.....
1842	1,286,618	230,000	21,586	.....	.....	.....	.....	.....
1843	1,478,926	312,000	21,000	.....	.....	.....	.....	.....
1844	1,899,805	394,000	22,000	2,680*	.....	.....	.....	.....
1845	2,352,984	486,000	26,500	100	.....	.....	.....	.....
1846	2,707,321	765,000	25,000	150	.....	.....	.....	.....
1847	3,327,155	800,000	25,000	300	.....	20,000,000*	.....	.....
1848	3,572,695	800,000	22,500	500	.....	10,000,000	.....	.....
1849	3,724,806	650,000	21,000	700	.....	40,000,000	.....	.....
1850	3,863,365	563,755	19,500	600	25,424*	50,000,000	.....	.....
1851	5,190,690	413,000	16,500	800	24,000	55,000,000	.....	.....
1852	5,725,148	540,755	14,000	1,000	20,000	60,000,000	.....	.....
1853	5,940,905	723,214	15,000	1,850	19,000	65,000,000	.....	.....
1854	6,846,556	662,216	14,000	2,250	27,000	60,000,000	.....	.....
1855	7,684,542	700,159	14,000	3,000	33,000	55,000,000	.....	.....
1856	7,999,767	788,515	14,000	4,000	30,000	55,000,000	.....	.....
1857	7,694,842	712,640	14,000	4,800	28,000	55,000,000	.....	.....
1858	7,864,230	629,552	14,000	5,500	31,000	50,000,000	1,000,000*	.....
1859	9,010,726	750,560	14,000	6,300	12,000	50,000,000	100,000	3,200
1860	9,807,118	821,223	14,000	7,200	10,000	46,000,000	150,000	650,000
1861	9,147,461	653,164	14,000	7,500	35,000	43,000,000	2,000,000	2,113,600
1862	9,026,211	702,912	14,000	9,000	42,000	39,200,000	4,500,000	3,056,606
1863	10,953,077	846,075	14,000	6,474	40,531	40,000,000	8,500,000	2,611,359
1864	11,631,400	1,013,837	14,000	6,518	47,489	46,100,000	11,000,000	2,116,182
1865	10,783,032	831,768	13,165	6,811	53,000	53,200,000	11,250,000	3,497,712
1866	14,233,919	1,200,199	14,342	6,978	46,550	53,500,000	10,000,000	3,597,527
1867	14,345,644	1,305,015	13,662	7,774	37,000	51,700,000	13,550 000	3,347,306
1868	15,810,466	1,431,250	14,636	9,467	37,000	48,000,000	12,000,000	3,715,741
1869	16,375,678	1,711,276	15,653	11,858	33,713	49,500,000	13,000,000	4,215,000
1870	17,819,700	1,696,429	15,922	12,650	29,546	50,000,000	16,000,000	5,659,000
1871	17,370,463	1,707,685	17,854	12,546	31,881	43,500,000	22,000,000	5,795,000
1872	22,032,265	2,539,783	23,106	11,948	30,306	36,000,000	25,750,000	6,539,103
1873	22,828,178	2,560,962	46,661	15,573	28,600	35,000,000	36,500,000	9,879,455
1874	21,667,386	2,401,261	53,219	17,548	34,254	39,600,000	32,800,000	10,910,303
1875	20,643,509	2,108,554	53,000	15,625	53,706	33,400,000	41,400,000	8,787,506
Total,	341,521,423	40,000,000	855,000	200,000	840,000	1,332,700,000	261,450,000	76,594,600

* Including the whole previous period from 1776.

Production of Quicksilver at New Almaden for Twenty-three Years and Three Months.

Dates.	Class and Quantity of Ore.			Total pounds.	Flasks from furnaces.	Flasks from washings.	Flasks, total.	Average am't per month, flasks.	Percentage, including all.	Percentage, Tierras.	True per ct. of ore ex'ld. tier. & w'ngs.	No. of months.
	Grueso, Pounds.	Granza, Pounds.	Tierras. Pounds.									
July 1850 to June 1851.	. . . . .	. . . . .	. . . . .	4,970,717	23,875	. . . .	23,875	1,989½	36 74	. . . .	36 74	12
" 1851 " " 1852.	. . . . .	. . . . .	. . . . .	4.643,290	19,921	. . . .	19,921	1,660	32.82	. . . .	32.82	12
" 1852 " " 1853.	. . . . .	. . . . .	. . . . .	4,839,520	18,035	. . . .	18,035	1,503	28.50	. . . .	28.50	12
" 1853 " " 1854.	. . . . .	. . . . .	. . . . .	7,448,000	26,325	. . . .	26,325	2,193¾	27.03	. . . .	27.03	12
" 1854 " " 1855.	. . . . .	. . . . .	. . . . .	9,109,300	31,860	. . . .	31,860	2,655	26.75	. . . .	26.75	12
" 1855 " " 1856.	. . . . .	. . . . .	. . . . .	10,355,200	28,083	. . . .	28,083	2 340¼	20.74	. . . .	20.74	12
" 1856 " " 1857.	. . . . .	. . . . .	. . . . .	10,299,900	26,002	. . . .	26,002	2,167	19.31	. . . .	19 31	12
" 1857 " " 1858	. . . . .	. . . . .	. . . . .	10,997,170	29,347	. . . .	29,347	2,445½	20.41	. . . .	20.41	12
" 1858 " Oct. 1858.	. . . . .	. . . . .	. . . . .	3,873,085	10,588	. . . .	10,588	2,647	20.91	. . . .	20.91	4
Nov. 1858 " Jan. 1861.	Closed	by Injunction.										
Feb. 1861 " " 1862.	. . . . .	. . . . .	. . . . .	13,323,200	32.402	2,363	34,765	2,897	19.96	. . . .	18.64	12
" 1862 " " 1863.	. . . . .	. . . . .	. . . . .	15,281,400	39,262	1,129	40,391	3,366	20.22	. . . .	19.65	12
" 1863 " Aug. 1863.	. . . . .	. . . . .	. . . . .	7,172,660	17,316	2,248	19,564	2,795	20.86	. . . .	18.46	7
Sep. 1863 " Oct. 1863.	. . . . .	. . . . .	. . . . .	2,346,000	4,820	700	5,520	2,760	18.00	. . . .	15.67	2
Nov. 1863 " Dec. 1863.	54,800	1,586,500	718,000	2,359,300	4,040	407	4,447	2,223½	18 65	3	17.52	2
Jan. 1864 " " 1864.	1,259,400	18,730,300	3,287,900	23,277,600	42,176	313	42,489	3,540¼	13.96	3	15.64	12
" 1865 " " 1865.	2,288,900	25.749,000	3,910,500	31,948,400	47,078	116	47,194	3,933	11.30	3	12.42	12
" 1866 " " 1866.	1,506,000	19,939,100	5,440,200	26,885,300	34,726	424	35,150	2,929	10.00	3	11.62	12
" 1867 " " 1867	731,500	15,689,288	9,603,145	26,023,933	23,990	471	24,461	2,038½	7.19	3	9.42	12
" 1868 " " 1868.	2,274,208	14,566,600	12,564,722	29,405,530	25,577	51	25,628	2,135⅔	6.66	2	10.12	12
" 1869 " " 1869.	150,000	11 942,175	13,366,000	25,458,175	16,898	. . . .	16,898	1,408	5 07	2	8.48	12
" 1870 " " 1870.	30,000	12,531,900	8,535,800	21,097,700	14,423	. . . .	14,423	1,202	5.23	2	7.42	12
" 1871 " " 1871.	. . . . .	13,661,700	8,373,000	22.034,700	18,563	5	18,568	1,547⅓	6.44	2	9.16	12
" 1872 " " 1872.	142,000	12,777,000	8,497,600	21,416,600	18,391	183	18,574	1,548	6.63	2	9.57	12
" 1873 " " 1873	. . . . .	8,492,375	8,838.000	17,330,375	11,042	. . . .	11,042	920	4.87	2	7 86	12
" 1874 " " 1874.	. . . . .	11,294,000	12,160,000	23,454,000	8,867	217	9,084	757	2.96	1.59	4.29	12
" 1875 " " 1875.	. . . . .	12,236,000	18,870,200	31,106,200	13,541	107	13,648	11.37⅓	3.35	1	6.92	12
Totals and averages,	8,436,808-	179,195,938	114,165,067	406,457,255	587,148	8,734	595,882	21.35¾	11.21	1.99	14.58	279

Product of Enriqueta from 1860 to 1863, 10,571.

Total product of all the mines on the Company's property, 606,453 flasks of 76½ lbs. each, or 46,393,654½ lbs.—*San Francisco Scientific Press.*

Production of Comstock Lode.

1860,	$1,000,000
1861,	2,275,256
1862,	6,247,047
1863,	12,486,238
1864,	15,795,585
1865,	15,184,877
1866,	14,167,071
1867,	13,738,618
1868,	8,499,769
1869,	7,528,607
1870,	8,319,698
1871,	11,053,328
1872,	13,569,724
1873,	21,534,727
1874,	22,400,783
1875,	26,023,036
	$199,824,364

Or, in round numbers, $200,000,000; of which, about $80,000,000 has been gold, and $120,000,000 silver, according to Mr. J. D. Hague.

Production of Iron Ore and Pig-iron at Lake Superior.

Dates.	Ore. Tons.	Pig-iron. Tons.	Total.	Value.
1856.	7,000	. . . . .	7,000	$28,000
1857.	21,000	. . . . .	21,000	60,000
1858.	31,035	1,629	32,684	249,202
1859.	65,679	7,258	72,937	575,529
1860.	110,908	5,660	122,568	736,496
1861.	45,430	7,970	53,400	419,501
1862.	115,721	8,590	124,311	984,977
1863.	185,257	9,813	195.070	1,416,935
1864.	235,123	13,832	248,955	1,867,215
1865.	196,256	12,283	208,539	1,590,430
1866.	296,972	18,437	315,409	2,405,960
1867.	466,076	30,911	496,987	3,475,820
1868.	507,813	38,246	546,059	3,992,413
1869.	633,238	39,003	672,241	4,968,435
1870.	856,471	49,298	905,769	6,300,170
1871.	813,379	51,225	864,604	6,115,895
1872.	952,055	63,195	1,015,250	9,188,055
1873.	1,066,875	35,245	1,102,120	7,500,000
1874.	840,295	72,740	913,035	6,800,000
1875.	829,115	76,874	905,989	6,900,000
	8,281,698	542,209	8,823,907	$65,575,033